American National Standard

Adopted for Use by the Federal Government

FIPS PUB 51

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magnetic tape cassettes for information interchange (3.810-mm [0.150-in] tape at 32 bpmm [800 bpi], PE)

american national standards institute, inc.
1430 broadway, new york, new york 10018

ANSI X3.48-1977

This standard has been adopted for Federal Government use.

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X3.48-1977

American National Standard Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.150-in] Tape at 32 bpmm [800 bpi], PE)

Secretariat

Computer and Business Equipment Manufacturers Association

Approved May 11, 1976

American National Standards Institute, Inc

American National Standard

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Foreword

(This Foreword is not a part of American National Standard Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.150-in] Tape at 32 bpmm [800 bpi], PE), X3.48-1977.)

This standard presents the minimum requirements for mechanical and magnetic interchangeability of 3.810-mm (0.150-inch) wide magnetic tape and the associated tape cassette between information processing systems, communication systems, and associated equipment using American National Standard Code for Information Interchange, X3.4-1977 (ASCII), and related standards on magnetic tape at 32 bits per millimeter (800 bits per inch) using phase encoding techniques.

Subsequent standards may specify higher densities and other cassettes with wider and thicker tapes, and will define more fully the physical magnetic tape and specify a standard record format and labels. Other recording formats may also be specified.

The X3B5 Subcommittee, which developed this document, consists of a group of experienced and qualified specialists on recording of digital information on magnetic tape.

In the development of this standard, careful consideration was given to current practices, existing equipment and supplies, and the broadest possible acceptance while providing a basis for future improvement in the use of the medium.

This standard was approved as an American National Standard by the American National Standards Institute on May 11, 1976.

Suggestions for improvement of this standard will be welcome. They should be sent to the American National Standards Institute, 1430 Broadway, New York, N.Y. 10018.

This standard was processed and approved for submittal to ANSI by American National Standards Committee on Computers and Information Processing, X3. Committee approval of the standard does not imply that all committee members voted for its approval. At the time it approved this standard, the X3 Committee had the following members:

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American National Standard Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.150-in] Tape at 32 bpmm [800 bpi], PE)

1. Scope

1.1 This standard covers specifications and requirements for a 3.810-mm (0.150-in) magnetic tape cassette to provide data interchange and physical interchangeability between information processing systems utilizing the American National Standard Code for Information Interchange, X3.4-1977 (ASCII), and amendments thereto. The cassette is of the twin hub coplanar type, loaded with a 3.810-mm (0.150-in) wide magnetic tape for digital recording using the 31.5 bits per mm (800 bpi) phase encoding method. The direction of magnetiziation is in the longitudinal direction of the tape.

NOTE: Through the remainder of the standard, for the sake of simplicity, the recording density is stated as 32 bpmm (800 bpi) nominal.

1.2 This standard applies to cassettes and data used for interchange. Cases in which the standard applies for testing only are specifically stated.

2. Definitions

average signal amplitude. The average peak-to-peak value of the signal output measured over at least 4000 flux transitions.

bit density. The number of bit flux transitions per unit length of track.

erasing field. A unidirectional field of sufficient strength to remove the signals from the tape.

in contact. An operating condition in which the magnetic surface of a tape is in physical contact with a magnetic head.

leaders. Nonmagnetic transparent tapes joined to each end of the magnetic tape for reasons of strength and convenience.

magnetic tape. A tape that accepts and retains magnetic signals intended for input/output and storage purposes of information processing and associated systems.

position of flux transitions. The position of a flux transition is defined as that which exhibits the maximum free space flux density normal to the tape surface.

print-through. Any unwanted signals induced in one layer of tape by the field of a deliberately recorded signal in an adjacent layer or layers.

reference alignment cassette. A cassette containing tape on which continuous information has been recorded, where the optimum playback head gap alignment does not differ by more than 0.8 mrad (± 3 minutes of arc) from the vertical on the cassette support plane. (Currently these cassettes are available with wavelengths of 7.5 μm [295 μin] and 4.75 μm [187 μin].)

reference field. The minimum field that, when applied to the reference recording field tape cassette, causes a signal output equal to 95% of the maximum signal output at the specified test packaging density (see 4.3).

reference tape cassette. A tape cassette arbitrarily selected for a given property for calibrating purposes.

secondary reference tape cassette. A tape cassette intended for routine calibrating purposes, the performance of which is known and stated in relation to that of the reference tape cassette.

signal amplitude reference tape cassette. A reference tape cassette selected as a standard for signal amplitude.

NOTE: A Master Standard (Computer Amplitude) has been established at the U.S. National Bureau of Standards (NBS) based on reference tape cassettes and heads as the result of work by national standardization organizations and national laboratories coordinated by the NBS. Secondary signal amplitude reference tape cassettes are available from NBS under part number SRM 1600.

standard reference amplitude. The standard reference amplitude is the average peak-to-peak signal amplitude derived from the signal amplitude reference tape cassette, at the density of 63 flux transitions per milli-

meter (1600 flux transitions per inch) using the test recording current. The signal amplitude shall be averaged over 4000 flux transitions.

tape cassette centerline. In Fig. 1 through 6 (pages 16–21), the centerline of the cassette is defined as a line perpendicular to the prime reference line and located midway between the centers of the two reference holes (Fig. 4).

test recording current. A recording current between 145% and 155% of the current required to produce the reference field.

track. A longitudinal area of the tape along which a series of magnetic signals may be recorded.

typical field. The minimum field characteristic of each tape, which, when applied to the tape under test, causes a signal output equal to 95% of the maximum signal output at the specified test packing density.

3. Environment and Transportation

3.1 Testing Environment. Tests and measurement made on the cassette to check the requirements of this standard shall be carried out under the following conditions:

Temperature:	23°C ± 2°C (73°F + 4°F, –3°F)
Relative humidity:	40% to 60%
Conditioning before testing:	24 hours minimum

3.2 Operating Environment. Cassettes used for data interchange shall be operated under the following conditions:

Temperature:	10°C to 45°C (50°F to 113°F)
Relative humidity:	20% to 80%
Wet-bulb temperature:	Less than 26°C (79°F)

The temperature should be measured in the air immediately surrounding the cassette. Rapid temperature variations should be avoided. There shall be no deposit of moisture on or in the cassette.

3.3 Transportation and Storage Environment. During transportation and storage, it is recommended that recorded cassettes be kept within the following conditions:

Temperature:	4°C to 50°C (40°F to 122°F)
Relative humidity:	20% to 80%

NOTE: Cassettes that have been exposed to temperatures exceeding the storage temperature range may exhibit degraded performance characteristics. Such cassettes should be subjected to a conditioning period of not less than 24 hours within the operating environment prior to use.

3.4 Transportation. Responsibility for ensuring that adequate precautions are taken during shipment shall be with the sender. During transport, the reels of tapes shall be blocked to prevent any tendency to unwind. For transport, a rigid container free from dust or extraneous matter shall be used. The final package shall have a clean interior and construction, preventing ingress of dust and water. It is recommended that a space of not less than 80 mm (3.2 in) exist between cassette and outer surface of the final container so that risk of damage due to stray magnetic fields will be negligible.

4. Characteristics of Tape

4.1 General. The tape shall consist of a base material (such as oriented polyethylene terephthalate film, or the equivalent) coated on one side with a strong and flexible layer of ferromagnetic material dispersed in a suitable binder. The magnetic tape shall be continuous and splice-free. Tape or cassette components that will ignite from a match flame and when so ignited will continue to burn in a still carbon dioxide atmosphere shall not be used. Tape or cassette components that may cause bodily harm by contact, inhalation, or ingestion during normal use of the cassette shall not be used.

4.2 Mechanical Properties

4.2.1 Tape and Leader Width and Tolerance. The width of tape and leader shall be 3.810 mm + 0 mm, – 0.050 mm (0.150 in + 0 in, – 0.002 in).

4.2.2 Tape and Leader Length

4.2.2.1 Tape Length. The length of the splice-free tape shall be 86 m + 4 m, – 0 m (283 ft + 12 ft, – 0 ft).

4.2.2.2 Leader Length. The length of the leader tape (dimension H_2 in Fig. 7 [page 22]) shall be such that the distance from the cassette face to the beginning of the magnetic tape is 500 mm ± 50 mm (19.7 in ± 1.9 in) when the leader tape is pulled out of the cassette through the opening nearest to the empty reel.

4.2.3 Tape and Leader Thickness

4.2.3.1 Thickness of Tape. The overall thickness of tape and coating shall be 19 μm (740 μin) maximum and 15 μm (590 μin) minimum, with a coating thickness of 6 μm (230 μin) maximum.

4.2.3.2 Thickness of Leader. The thickness of the leader shall be 38 μm (0.00149 in) maximum.

4.2.4 Markers

4.2.4.1 General. The magnetic tape shall be provided with beginning-of-tape (BOT) and end-of-tape (EOT) markers.

4.2.4.2 Dimensions. The markers shall be circular holes having a diameter of 0.60 mm ± 0.05 mm (0.0236 in ± 0.0019 in).

4.2.4.3 Position. The distance of the marker centers for the physical beginning and end of the magnetic tape (for BOT and EOT, respectively) shall be 450 mm ± 30 mm (17.7 in ± 1.1 in). The distance between tape centerline and marker centerline shall be less than 0.1 mm (0.0039 in).

4.2.5 Light Transmittance

4.2.5.1 Light Transmittance of Tape. The tape and the backing tape shall each have a light transmittance of less than 1% when measured in accordance with Appendix B.

4.2.5.2 Light Transmittance of Leader. The leader tape shall transmit 75% or more light when measured in accordance with Appendix B.

4.2.6 Strength

4.2.6.1 The elastic properties of the tape shall be such that when subjected to a tension of 0.5 N (0.112 lb_f) for a period of 3 minutes under any combination of temperature and relative humidity within the ranges given in 3.1, the elongation shall be between 0.08% and 0.50%.

4.2.6.2 The elastoplastic properties of the tape shall be such that when subjected to a tension of 3 N (0.67 lb_f) for a period of 3 minutes under temperature and humidity conditions as mentioned in 3.1, the (permanent) elongation measured with negligible tension after a second 3-minute interval shall be less than 1.0%.

4.2.6.3 The elastic properties of the tape shall be such that its tensile yield force – defined as the force required to elongate a sample by 3% – shall be at least 4.5 N (1.01 lb_f).

Procedure: Use a static weighing constant-rate-of-grip separation tester capable of indicating the load to an accuracy of ± 2%. Clamp a specimen of tape at least 180 mm (7 in) in length with an initial 100-mm (4-in) separation between jaws. Elongate the specimen at a rate of 50 mm (2 in) per minute until minimum elongation of 10% is reached. The force required to produce an elongation of 3% is the tensile yield force.

4.2.6.4 The elastic properties of the leader shall be such that when subjected to a tension of 1.0 N (0.225 lb_f) for a period of 3 minutes under temperature and humidity conditions given in 3.1, the elongation shall be between 0.08% and 0.50%.

4.2.7 Longitudinal Curvature. There shall be a minimum radius of curvature for the edge of the tape, defined and tested by allowing a l-m (39-in) length of tape to unroll and assume its natural curvature on a flat surface. The minimum radius shall be 33 m (108 ft), which, if measured over an arc of a circle, corresponds to a deviation of 3.8 mm from a l-m chord (0.15 in from a 39-in chord).

4.2.8 Tape-to-Leader Connection

4.2.8.1 Dimensions. A splicing tape, if used, shall not extend more than 18 mm (0.71 in) from the gap between leader and tape. The actual gap itself shall be 0.5 mm (0.02 in) maximum. An overlap of 0.05 mm (0.002 in) maximum is allowed. The thickness of the splicing tape shall be 50 μm (0.002 in) maximum.

4.2.8.2 Tape-to-Leader Alignment. At the area of the splice there shall be no lateral discontinuity greater than 100 μm (0.004 in). The total width of the magnetic tape–leader–splicing tape junction shall be no more than 3.86 mm (0.152 in).

4.2.8.3 Strength. After being subjected to a longitudinal static force of 2 N (0.45 lb_f) for 24 hours under the conditions of 3.2, the connection shall meet the requirements of 4.2.8.1.

4.2.9 Layer-to-Layer Adhesion. Layer-to-layer adhesion shall be sufficiently low to meet the test described in Appendix A.

4.3 Tests of Magnetic Properties. The magnetic properties of the tape are defined by the testing requirements given in 4.3.1 through 4.3.7.

4.3.1 Test Density. Tape shall be tested at 63 flux transitions per millimeter (1600 flux transitions per inch) nominal.

4.3.2 Typical Field. The typical field of the tape under test shall be within ± 20% of the reference field.

4.3.3 Average Signal Amplitude. When a tape has been recorded with the test recording current and then played back on a system which has been calibrated by means of a signal amplitude reference tape cassette recorded under the same conditions, the average signal amplitude of the tape under test shall be within + 25%, – 10% of the standard reference amplitude. In the performance of this test the output signal shall be measured for the same relative pass for both tapes (that is, read-while-write or read-on-first-pass-after-write).

4.3.4 Ease of Erasure. When a tape has been recorded with the test recording current and then passed through a longitudinal steady erasure field of 79.6 kA/m (1000 oersteds), the average signal amplitude of the remaining unwanted signal shall not exceed 3% of the standard reference amplitude. The erasure field shall be reasonably uniform – for example, the field in the middle of a solenoid. This measurement shall be made with a band-pass filter passing at least the first three harmonics.

4.3.5 Test for Dropouts and Drop-Ins. These tests shall be carried out in the in-contact condition and over the entire usable recording area (see Fig. 7), which shall extend in length from 350 mm (13.78 in) before

the BOT marker to 350 mm (13.78 in) beyond the EOT marker, and in width over the track widths as defined in 7.2.

In the performance of these tests the output signal shall be measured on the same relative pass for both the signal amplitude reference tape cassette and the tape under test (that is, read-while-write or read-on-first-pass-after-write).

4.3.5.1 Dropouts. When a tape has been recorded with the test recording current, any playback signal, when measured base-to-peak, that is less than 50% of half the standard reference amplitude is a dropout.

4.3.5.2 Drop-Ins. When a tape has been recorded with a constant recording current equivalent to the test recording current, any playback signal, when measured base-to-peak, that exceeds 10% of half the standard reference amplitude, is a drop-in.

4.3.6 Rejected Regions. A rejected region is an area of tape extending across the width of either track and not more than 10 mm (0.39 in) in length, which, on two consecutive tests, exhibits dropouts or drop-ins (see 6.6). The acceptable number of rejected regions in an interchange environment is a matter of agreement between interchange parties.

4.3.7 Print-Through. A tape for testing shall be written with a suitable pattern using the test recording current, rewound, and stored for a minimum of 16 hours at 60°C (140°F). At the end of this period the measured print-through signal shall not exceed 2% of the standard reference amplitude. Since the decay of the print-through signal on a section of tape is extremely rapid after it has been removed from the coil, the time elapsing between the tape's leaving the coil and its passing over the test read head shall not exceed 500 ms.

4.4 Electrical Surface Resistance. The surface resistance of the tape shall not exceed 1000 megohms per square.

NOTE: Resistance per square is the surface resistance of a square area of any size, measured between electrodes placed on two opposite sides of the square. The unit of the measurement is the ohm.

5. Tape Cassette

5.1 Identification of Cassette Sides

5.1.1 The cassette has its two sides distinguished and labeled A and B, respectively, corresponding to tracks 1 and 2 (see Fig. 1).

5.1.2 The back surface is provided with two holes whose minimum area, depth, and section are indicated in Fig. 1. Writing on a track is enabled by closing the outer surface of the corresponding hole. When a closing device other than a plug is used, it shall remain attached to the cassette.

5.1.3 The back surface is provided with one slot slightly off center (see Fig. 1). This slot makes it possible to distinguish between sides A and B both visually and mechanically.

5.2 Mechanical Characteristics. The mechanical characteristics that define the coplanar tape cassette and permit physical interchangeability of cassettes on any recorder for data interchange of different manufacture are specified in Fig. 1–6. Symmetry about the tape cassette centerline is required (except for the asymmetrical slot) with half the stated tolerances permitted on each side of the tape cassette centerline.

5.3 Basic Specifications. The basic specifications given in 5.3.1 through 5.3.11 apply.

5.3.1 Tape Path and Guidance. Requirements are as shown in Fig. 2 and 3.

5.3.2 Cassette Support Planes. The cassette shall be supported by the write/read instrument only where the total cassette thickness is obligatory – that is, the shaded areas in Fig. 5.

5.3.3 Holes in Back Surface. The position and dimensions of the holes in the back surface are given in Fig. 1. The dimensions of the write-enable device, if used, shall be compatible with the hole dimensions as shown in Fig. 1 and shall be such that it may be installed and removed with reasonable effort and remain seated during normal use. The write-enable device shall not protrude beyond the back surface, and it shall not be recessed more than 1 mm (0.039 in). The write-enable device shall at least close the crosshatched area as shown in Fig. 1.

5.3.4 Window Area. The maximum window area shall be in accordance with the dimensions given in Fig. 6. The maximum allowable increase in cassette thickness (required, for example, to accommodate marks indicating amount of wound and unwound tape) is given for each support plane.

5.3.5 Withdrawal Force. The minimum withdrawal force of the leader tape from the hub attachment shall be a static load of 10 N (2.25 lb_f) for a period of 10 minutes.

5.3.6 Tape Winding. The tape shall be wound on the hubs with the magnetic coating out in such a way that, when recording on track 1, and looking at label A, the tape is unwound in a counterclockwise direction.

5.3.7 Friction Torque of the Full Hub. The maximum friction torque of the full hub in the cassette shall be 2 mN·m (0.28 oz_f·in).

5.3.8 Friction Torque of Both Hubs. The maximum friction torque of both hubs measured in the cassette itself at the nearly full hub shall be 2.7 mN·m (0.38 oz_f·in). With a holdback torque of 0.8 mN·m (0.11 oz_f·in) applied to the nearly empty hub, the required

maximum torque to be applied to the nearly full hub shall not exceed 5.5 mN • m (0.78 oz_f • in).

5.3.9 Pressure Pad. The cassette shall be provided with a pressure pad to hold the magnetic tape against the write/read head. The pressure of the pad upon the head shall be 5 to 15 kPa (11.6 to 34.8 oz_f/in^2), when the minimum distance between head and reference line lies between 3.1 mm (0.122 in) and 3.8 mm (0.149 in). This pressure shall be measured on a symmetrically positioned circular cylindrical surface having a radius between 10 mm (0.39 in) and infinity (see Fig. 2).

Under these conditions and with a holdback torque of 0.8 mN • m (0.11 oz_f • in) applied to the nearly empty hub, the required maximum torque applied to the nearly full hub shall not exceed 16 mN • m (2.25 oz_f • in) to start tape motion and shall not exceed 12.5 mN • m (1.78 oz_f • in) to continue tape motion.

Measured from the centerline of the cassette, the pressure pad shall extend on both sides of this centerline in the direction of tape travel a minimum of 2.5 mm (0.099 in) and a maximum of 4 mm (0.157 in). Up to the distance of 2.5 mm (0.099 in) the pressure requirements still apply. The pressure pad shall be symmetrically positioned, and the distances between pressure pad and cassette support planes surrounding the reference holes shall not exceed 3.5 mm (0.137 in). Those values shall also be valid under actual working conditions.

No magnetic material may be used for the cassette construction near the position of the write/read head. No screening shield may be used, and the pressure pad and its holder shall be of nonmagnetic material.

5.3.10 Tape Guides. The tape touches the cassette at points on either side of the tape head recesses (indicated by arrows U and L in Fig. 3).

Guides are required at these positions. Between the outer guides (P and S) there must be a closed construction so as to prevent dust from entering the cassette.

The guides indicated by the letter L shall be perpendicular to the lower support plane (see 5.3.2). The guides indicated by the letter U shall be perpendicular to the upper support plane.

5.3.11 Transverse Tolerances of Tape Position

5.3.11.1 Transverse Tolerances without Tape Tension. The extreme position of the tape in the head region when no tape tension is present shall be limited by means incorporated in the cassette. The distance between cassette support planes surrounding the reference holes and those means shall lie between 3.5 mm (0.1387 in) and 3.7 mm (0.1456 in).

5.3.11.2 Transverse Tolerances with Tape Tension. If the tape is not influenced or touched by any external means (guides, heads, capstans), during wind or rewind, the tape edges shall have a distance of 4.1 mm ± 0.2 mm (0.1614 in ± 0.0078 in) from the support plane surrounding the reference holes (see Fig. 4 and 5). When track 1 is being used, the side B outer cassette surface is the reference plane. Conversely, when track 2 is being used, the side A outer cassette surface is the reference plane.

5.4 Labeling of Tape Cassettes

5.4.1 Label Area. The maximum label area shall be in accordance with the dimensions given in Fig. 6. The maximum allowable depression in the thickness of the cassette in the label area is given for each support plane.

5.4.2 Interchange. Suitable labels shall be used for marking contents of the cassette. The use of pencil or erasable material is not allowed. Position and size of labels used shall be less than the provided depression of the label area.

5.4.3 Identification. The label shall have provisions for the identification of owner, manufacturer, cassette side, and interchange label. The label shall indicate:

(1) That the cassette is meant for data interchange (see Section 1, Scope)

(2) The use of track 2 (see 7.4)

(3) Whether 7- or 8-bit coding is used (see 7.7)

(4) The method of recording

5.5 Magnetic Properties of the Cassette Housing. The magnetic properties of the cassette housing shall not impede bulk erasure of the tape by an external device.

6. Recording

6.1 Method of Recording. The method of recording shall be phase encoding, and shall be as described in 6.1.1 through 6.1.4.

6.1.1 The tape before the first block, the interblock gaps, and that part of the tape following the last block written shall be erased with the same polarity. This polarity is such that the beginning of the relevant track is a north-seeking pole.

This erasing process forms part of the recording procedure.

6.1.2 A "zero" bit is defined as a flux transition to the polarity opposite to that of the interblock gap, when reading in the forward direction.

6.1.3 A "one" bit is defined as a flux transition to the polarity of the interblock gap, when reading in the forward direction.

6.1.4 Additional flux transitions shall be recorded at the nominal midpoints between bit flux transitions as defined in 6.1.2 and 6.1.3, if required, to establish the proper polarity for the succeeding bits. These flux transitions shall be called phase flux transitions.

6.2 Equipment. The equipment and tape used for interchange shall satisfy the requirements of 6.3 through 6.8.

All signal measurements are made at a point in the read chain where the amplitude is proportional to the rate of change of flux in the read head.

6.3 Density of Recording

6.3.1 The density of recording is 32 bpmm (800 bpi) nominal.

6.3.2 The long-term average bit spacing is the spacing between bit flux transitions that have been recorded continuously at a nominal density of 32 flux transitions per millimeter (800 flux transitions per inch) and must be measured over a length of tape of not less than 3.81 m (12.5 ft).

The long-term average bit spacing shall be within ± 4% of the nominal spacing of 31.75 μm (1250 μin).

6.3.3 The short-term average bit spacing referred to a particular bit spacing is the average of the preceding four bit spacings.

The short-term average bit spacing shall be within the limits of ± 5% of the long-term average bit spacing.

In addition, the short-term average bit spacing shall not change at a rate greater than 2% per bit.

6.4 Flux Transition Spacing

6.4.1 The spacing between successive data bit flux transitions shall not differ from the preceding bit spacing by more than 10%.

6.4.2 The spacing between a phase flux transition and the preceding data bit flux transition shall be between 45% and 55% of the preceding bit spacing.

6.5 Signal Amplitude

6.5.1 Average Signal Amplitude

6.5.1.1 The average peak-to-peak signal amplitude of the interchanged tape cassette at 63 flux transitions per millimeter (1600 flux transitions per inch) shall not deviate by more than + 50%, − 35% from the standard reference amplitude. Averaging shall be done over a minimum of 400 flux transitions, which, for the interchange cassette, may be segmented into blocks.

6.5.1.2 The average peak-to-peak signal amplitude at 32 flux transitions per millimeter (800 flux transitions per inch) nominal shall be less than two times the standard reference amplitude.

6.5.1.3 Averaging shall be done on the first-read-pass-after-interchange.

6.5.2 Minimum Signal Amplitude. No tape cassettes intended for interchange shall contain any adjacent flux transitions whose base-to-peak signal amplitude is less than 35% of half the standard reference amplitude. This check is to be made during read-while-write or read-on-first-pass-after-write.

6.6 Number of Elongated Gaps. The number of gaps that have been elongated (see 7.11.4) due to erase instructions is a matter of agreement between interchange parties, but it is recommended that this number not exceed 2, or alternatively 1% of the total number of blocks written, whichever figure is larger.

6.7 Alignment Error. When adjusted for maximum output, the azimuth angles for a reference alignment cassette and the information to be interchanged shall not differ by more than ± 4.3 mrad (± 15 minutes of arc).

6.8 Tape Winding Torque. The take-up torque shall be at least 3 mN • m (0.43 oz_f • in). The maximum continuous value of the take-up tape tension shall be constant or decrease with increasing reel diameter and shall not exceed 0.5 N (1.81 oz_f). These values apply during winding, rewinding, recording, and playback.

6.9 Residuals of Previous Recordings. In the zone of the tape in which the outer edges of the tracks are allowed to vary (see 7.2.2), there can be residuals of previous recordings.

7. Format

7.1 Number of Tracks. There shall be two tracks (see Fig. 8 [page 23]).

7.2 Track Dimensions

7.2.1 Track Width. The track width shall be 1.45 mm (0.0571 in) nominal.

7.2.2 Distances between Tape Centerline and Track Edges. The distance between the centerline of the tape and the outer edges of the tracks shall be between 1.830 mm (0.0721 in) and 1.905 mm (0.750 in). The distance between the tape centerline and the inner edges of the tracks shall be between 0.37 mm (0.0146 in) and 0.51 mm (0.0200 in).

7.3 Track Designation

7.3.1 With side A up, the designation of the two tracks is as follows:

When the tape moves from left to right with the magnetic surface facing the observer, and with the leader of side A to the right, the bottom track is designated track 1 and the upper track is designated track 2 (see Fig. 1).

7.3.2 The recording starts with track 1; at its conclusion the cassette may be turned over and the recording can be continued with track 2.

7.4 Use of Tracks. The use of track 1 is reserved for data interchange. The use of track 2 is to be indicated on the label. If it is not used in the same way as track

1, reading of track 2 requires agreement between sender and recipient of the cassette.

7.5 Location of Characters on the Tracks. Each character is located in a byte (octet) of eight bit positions along the track numbered from 1 to 8 in order of recording.

7.6 Sequence of Recording. The least significant bit is recorded first. The information to be interchanged is recorded serially by bit and by character.

Bit positions: . . . 4 3 2 1 8 7 6 5 4 3 2 1 8 7 6 5 4 3 2 . . .

Forward tape motion: ——————————→

Resulting recording direction: ←——————————

7.7 Code. The characters are represented by means of the American National Standard Code for Information Interchange, X3.4-1977 (ASCII), and related standards.

7.7.1 Recording of 7-Bit Coded Characters. Each 7-bit coded character is recorded in bit positions 1 to 7 of a byte; bit position 8 is recorded with value zero. The relationship is as follows:

Bit of the 7-bit combination:	0	b_7	b_6	b_5	b_4	b_3	b_2	b_1
Bit position in the byte:	8	7	6	5	4	3	2	1

7.7.2 Recording of 8-Bit Coded Characters

Bits of the 8-bit combination:	a_8	a_7	a_6	a_5	a_4	a_3	a_2	a_1
Bit position in the byte:	8	7	6	5	4	3	2	1

7.8 Sequence of Characters. The sequence of characters from the start toward the finish of a block corresponds to the normal left-to-right sequence of a written line.

7.9 Data Block. A data block shall consist of a preamble, data, and postamble. The data portion of a data block including the CRC (see 7.13) shall contain a minimum of 32 bits and a maximum of 2064 bits.

7.10 Control Block. A control block (known as tape mark) shall consist of a preamble, two bytes of eight "zero" bits each, and a postamble.

7.11 Gaps

7.11.1 Integrity of Gaps. The gaps shall be dc-erased. Immediately before and after each block there shall be a length of at least 2.5 mm (0.10 in) in which, exclusive of the residual edge signals, there is no flux discontinuity capable of producing a read signal of more than 10% of half the standard reference amplitude. In the remaining part of the gap there shall be no more than seven flux transitions.

7.11.2 Interblock Gaps. The interblock gap, defined as the distance between two successive blocks, shall have a nominal length of 20.3 mm (0.80 in), a minimum length of 1.78 mm (0.70 in), and a maximum length of 250 mm (9.84 in). Any gaps in excess of 400 mm (15.2 in) shall be considered end of data on this track.

7.11.3 Initial Gap. The gap between the BOT marker and the first block shall be 33 mm (1.30 in) minimum and 250 mm (9.8 in) maximum.

7.11.4 Elongated Gap. The interblock gap is an elongated gap if its length is between 50 mm and 250 mm (1.97 in and 9.84 in).

7.11.5 Trailer Gap. The gap following the last block shall have a minimum length of 17.8 mm (0.70 in). At least 17.8 mm (0.70 in) of this gap shall lie within the tested area (see 4.3.5).

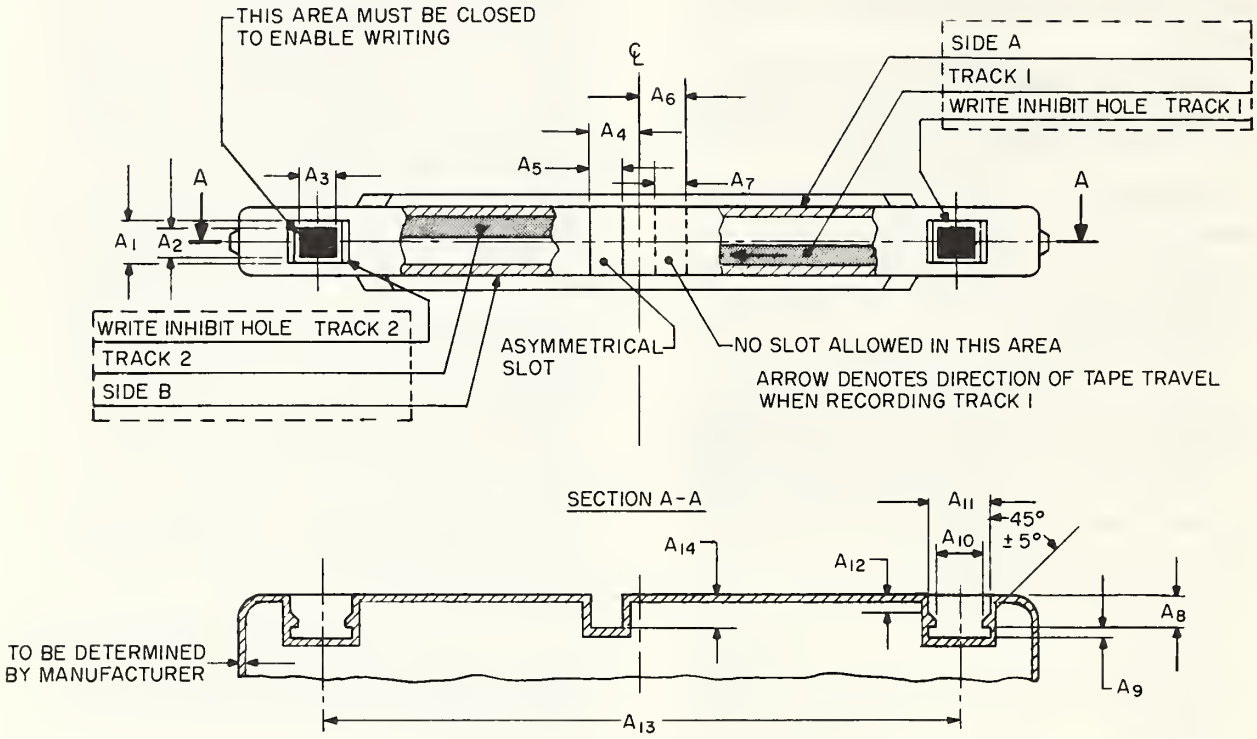
7.12 Preamble and Postamble

7.12.1 Preamble. Immediately preceding data in each block, the preamble "10101010" shall be written. When reading in the forward direction, the first bit flux transition shall be a zero transition.

7.12.2 Postamble. Immediately following data in each block, the postamble "10101010" shall be written. When reading in the forward direction, the first bit flux transition shall be a zero transition.

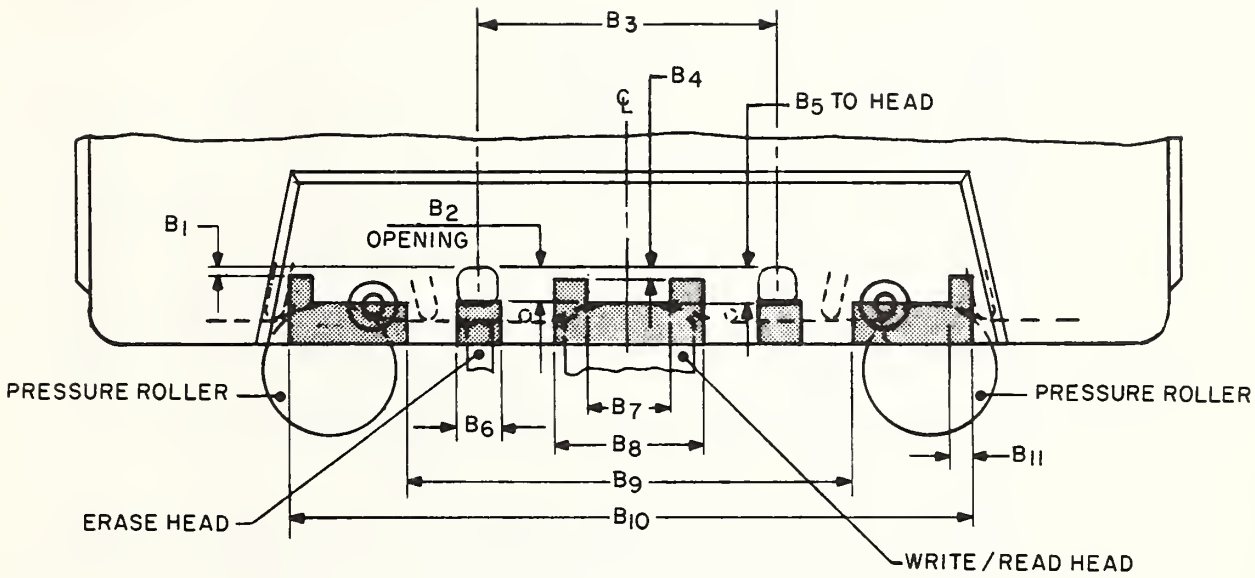
7.13 Cyclic Redundancy Check (CRC). The last two characters in the data portion of a data block shall be cyclic redundancy check (CRC). The 16-bit CRC shall be written in each data block following the data and immediately preceding the postamble. The polynomial generating the CRC is expressed as:

$$x^{16} + x^{15} + x^2 + 1$$



Dimension	Inches		Millimeters	
	Min	Max	Min	Max
A_1	0.1930	0.2007	4.9	5.1
A_2	0.138	–	3.5	–
A_3	0.197	–	5.0	–
A_4	0.2323	0.2401	5.9	6.1
A_5	0.1575	–	4.0	–
A_6	0.2323	0.2401	5.9	6.1
A_7	0.1575	–	4.0	–
A_8	0.1536	0.1614	3.9	4.1
A_9	0.0453	0.0492	1.15	1.25
A_{10}	0.2323	0.2401	5.9	6.1
A_{11}	0.2874	0.2953	7.3	7.5
A_{12}	0.0945	0.1023	2.4	2.6
A_{13}	3.154	3.177	80.1	80.7
A_{14}	0.1575	–	4.0	–

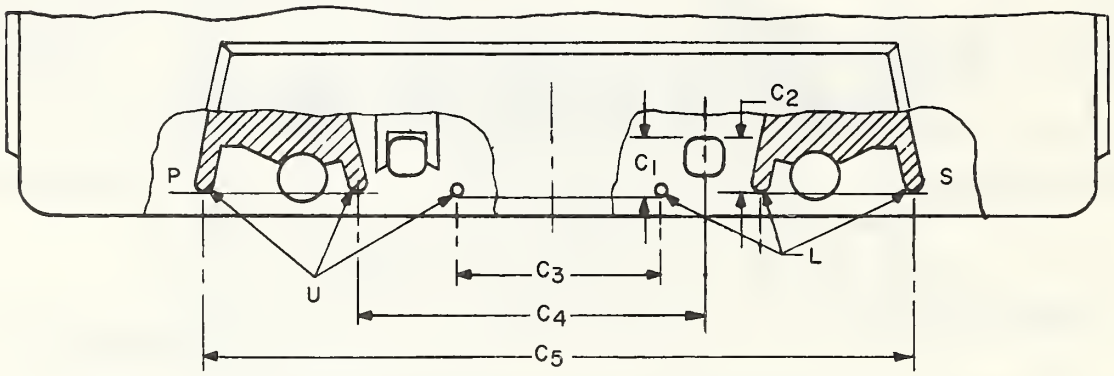
Fig. 1
Sides, Tracks, Holes, and Asymmetrical Slot



NOTE: Shaded areas define openings over the full height of the cassette aperture, unobstructed by fixed members, except for areas covered by the magnetic tape and pressure pad.

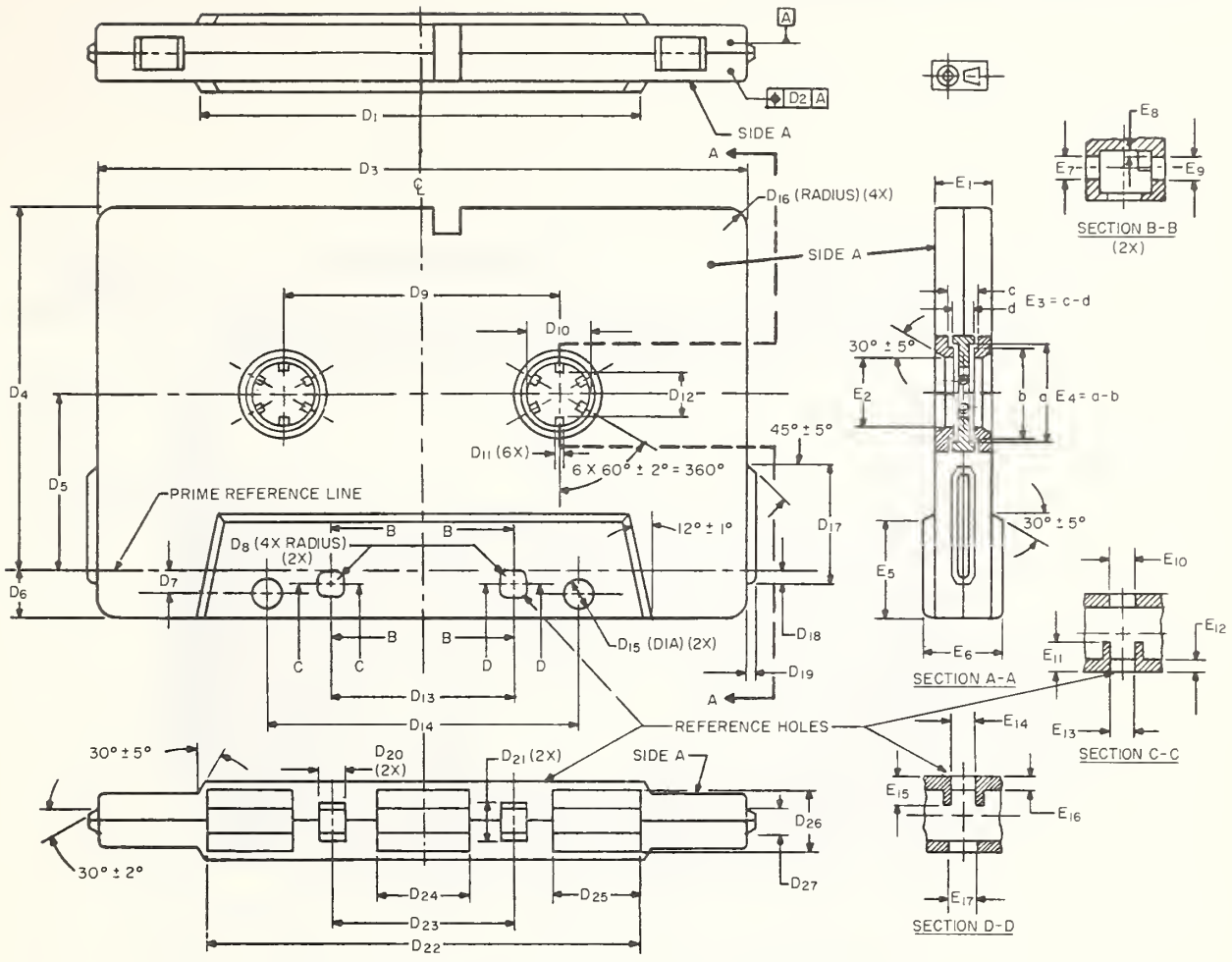
	Inches		Millimeters	
Dimension	Min	Max	Min	Max
B_1	–	0.0275	–	0.7
B_2	–	0.1220	–	3.1
B_3	1.093	1.112	27.75	28.25
B_4	–	0.0433	–	1.1
B_5	0.122	0.149	3.10	3.80
B_6	0.150	–	3.8	–
B_7	–	0.31	–	8
B_8	0.548	–	13.9	–
B_9	–	1.633	–	41.5
B_{10}	2.493	–	63.3	–
B_{11}	0.08	–	2	–

Fig. 2
Position of Heads



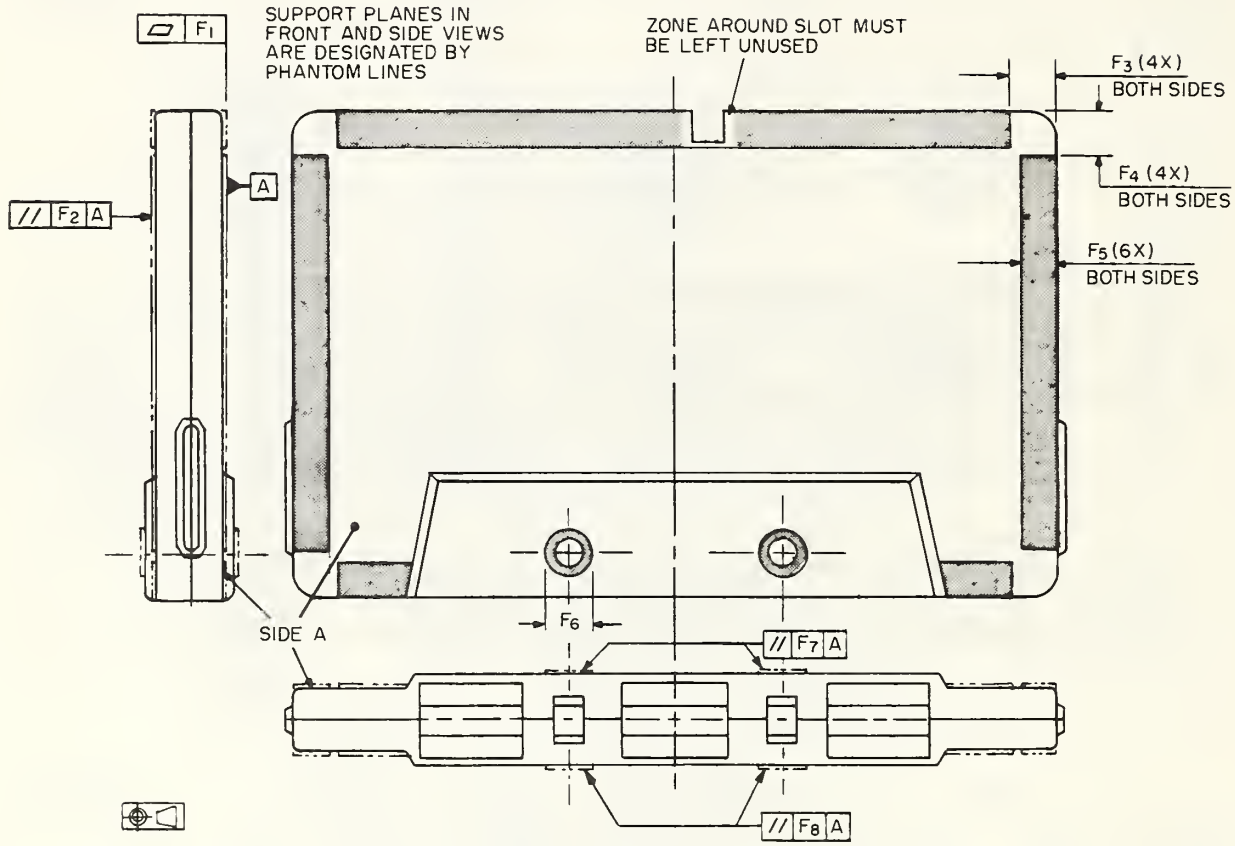
	Inches		Millimeters	
Dimension	Min	Max	Min	Max
C_1	0.2048	0.2086	5.2	5.3
C_2	0.1930	0.1968	4.9	5.0
C_3	0.7481	0.7637	19.0	19.4
C_4	1.4646	1.4803	37.2	37.6
C_5	2.6142	2.6229	66.4	66.8

Fig. 3
Tape Guides in Cassette



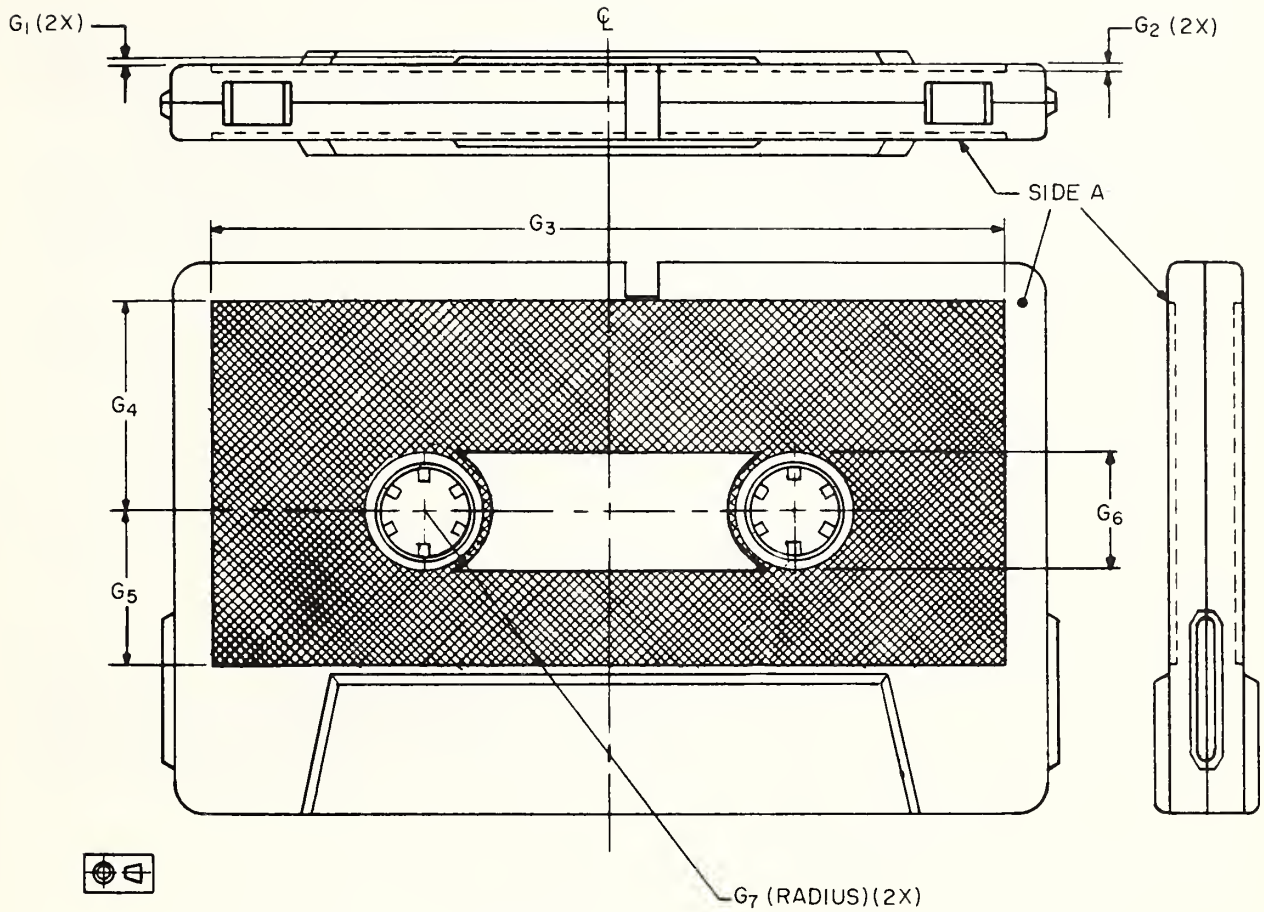
Dimension	Inches Min	Inches Max	Millimeters Min	Millimeters Max
D_1	2.658	2.696	67.5	68.5
D_2	0	0.0078	0	0.2
D_3	3.941	3.964	100.1	100.7
D_4	2.2284	2.2519	56.6	57.2
D_5	1.0926	1.1043	27.75	28.05
D_6	0.2638	0.2795	6.7	7.1
D_7	0.1260	0.1417	3.2	3.6
D_8	0.0512	0.0590	1.3	1.5
D_9	1.662	1.685	42.2	42.8
D_{10}	0.3937	0.4094	10.0	10.4
D_{11}	0.0512	0.0669	1.3	1.7
D_{12}	0.3071	0.3149	7.8	8.0
D_{13}	1.0965	1.1082	27.85	28.15
D_{14}	1.8819	1.8976	47.8	48.2
D_{15}	0.1733	0.1889	4.4	4.8
D_{16}	0.099	0.137	2.5	3.5
D_{17}	0.693	0.724	17.6	18.4
D_{18}	0.067	0.098	1.7	2.5
D_{19}	0.0355	0.0433	0.9	1.1
D_{20}	0.1497	0.1653	3.8	4.2
D_{21}	0.237	0.267	6.0	6.8
D_{22}	2.626	2.649	66.7	67.3
D_{23}	1.093	1.112	27.75	28.25
D_{24}	0.548	0.570	13.9	14.5
D_{25}	0.508	0.535	12.9	13.6
D_{26}	0.3859	0.3937	9.8	10.0
D_{27}	0.1182	0.1338	3.0	3.4
E_1	0.3347	0.3503	8.5	8.9
E_2	0.4292	0.4448	10.9	11.3
E_3	–	0.0511	–	1.3
E_4	0.0394	0.0748	1.0	1.9
E_5	0.571	0.610	14.5	15.5
E_6	0.4685	0.4842	11.9	12.3
E_7	0.1457	0.1496	3.7	3.8
E_8	0.016	–	0.4	–
E_9	0.1457	0.1496	3.7	3.8
E_{10}	0.154	0.177	3.9	4.5
E_{11}	0.166	0.188	4.2	4.8
E_{12}	0.0748	0.0826	1.9	2.1
E_{13}	0.1418	0.1456	3.6	3.7
E_{14}	0.1418	0.1456	3.6	3.7
E_{15}	0.166	0.188	4.2	4.8
E_{16}	0.0748	0.0826	1.9	2.1
E_{17}	0.154	0.177	3.9	4.5

Fig. 4
Cassette Dimensions



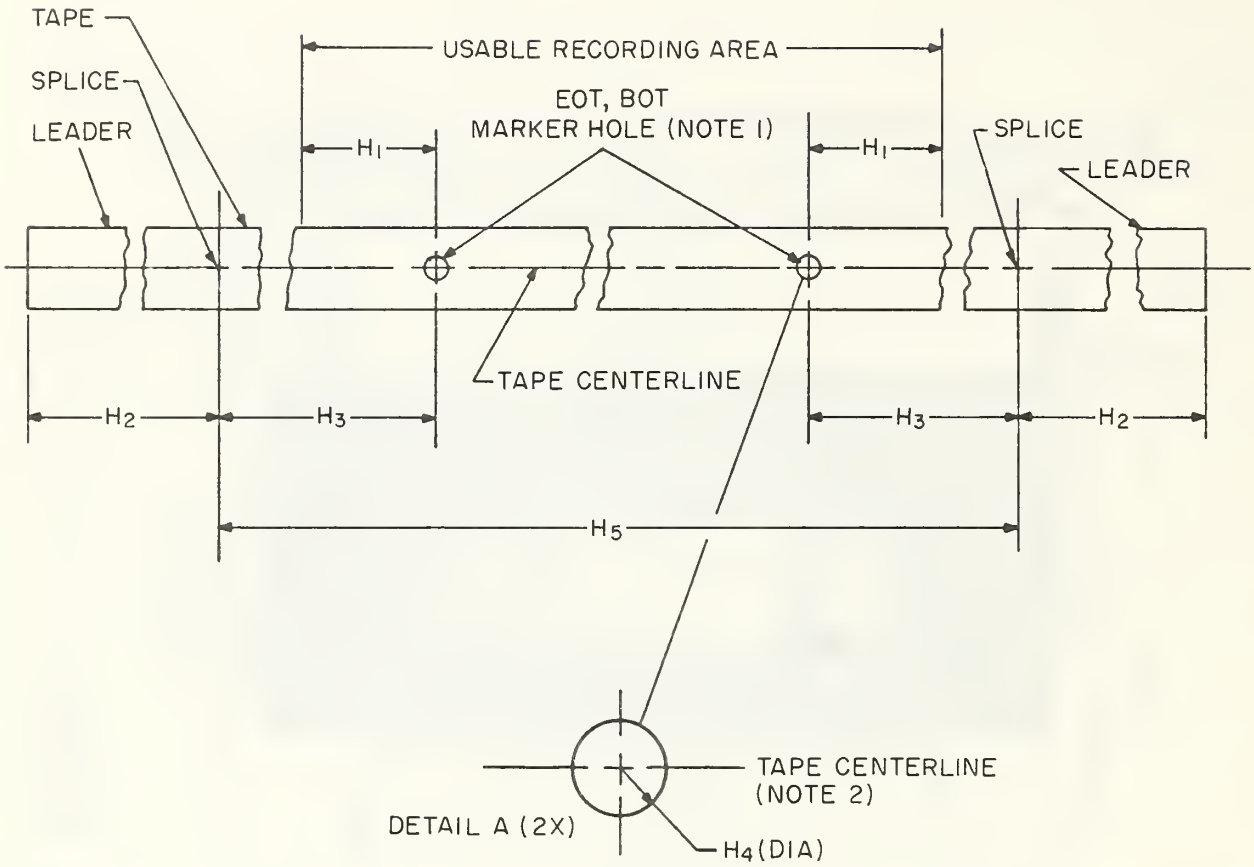
Dimension	Inches		Millimeters	
	Min	Max	Min	Max
F_1	0	0.0078	0	0.2
F_2	0	0.0078	0	0.2
F_3	–	0.23	–	6.0
F_4	–	0.23	–	6.0
F_5	0.178	–	4.5	–
F_6	0.2363	–	6.0	–
F_7	0	0.0039	0	0.1
F_8	0	0.0039	0	0.1

Fig. 5
Cassette Support Planes



Dimension	Maximum Value	
	Inches	Millimeters
G_1	0.0118	0.3
G_2	0.0118	0.3
G_3	3.5	91.1
G_4	0.95	24.3
G_5	0.71	18.2
G_6	0.52	13.3
G_7	0.31	8.0

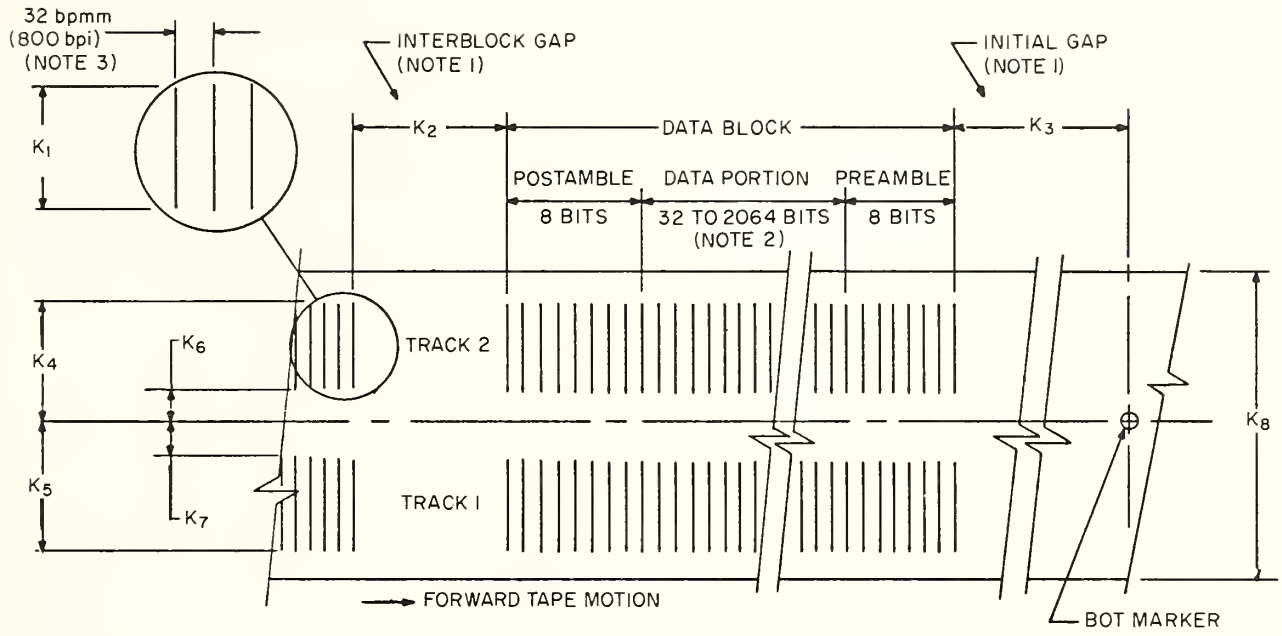
Fig. 6
Maximum Dimensions of Label and Window Areas



NOTES:
(1) Marker to be hole as shown in Detail A.
(2) Distance between tape centerline and marker centerline shall be less than 0.1 mm (0.0039 in).
(3) See 4.2.2.2.

	Inches			Millimeters		
Dimension	Min	Nom	Max	Min	Nom	Max
H_1	–	13.78	–	–	350	–
H_2 (Note 3)	–	–	–	–	–	–
H_3	16.6	–	18.8	420	–	480
H_4	0.0217	–	0.0255	0.55	–	0.65
	Feet			Meters		
H_5	283	–	295	86	–	90

Fig. 7
Usable Recording Area



NOTES:
(1) Tape is fully saturated in the erase direction in the interblock gap and the initial gap.
(2) The last 2 characters (16 bits) of the data portion are used for the cyclic redundancy check (CRC).
(3) Shown without phase flux reversals that may exist between data bits.
(4) Tape is shown with oxide side out.

	Inches			Millimeters		
Dimension	Min	Nom	Max	Min	Nom	Max
K_1	–	0.0571	–	–	1.45	–
K_2	0.701	–	–	17.8	–	–
K_3	1.30	–	–	33	–	–
K_4	0.0721	–	0.0750	1.830	–	1.905
K_5	0.0721	–	0.0750	1.830	–	1.905
K_6	0.0146	–	0.0200	0.37	–	0.51
K_7	0.0146	–	0.0200	0.37	–	0.51
K_8	0.148	–	0.150	3.760	–	3.810

Fig. 8
Recording Format, 32 bpmm (800 bpi)

Appendixes

(These Appendixes are not a part of American National Standard Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.150-in] Tape at 32 bpmm [800 bpi], PE), X3.48-1977, but are included for information purposes only.)

Appendix A
Layer-to-Layer Adhesion

A piece of the tape to be tested, about 1 m (39 in) in length, is wound around a glass pipe 36 mm (approximately 1.4 in) in diameter, with a tension of 3 N (0.67 lb_f), and fixed at the end. This should be stored for 24 hours at a temperature of 45°C ± 3°C (113°F ± 5°F) and at 80% relative humidity. After this period it should be stored for another 24 hours in the testing environment specified in Section 3 of this standard. The tape should then be unwound with a mass of 5 g (0.18 oz) at the end of tape as shown in Fig. A1, and the angle (θ) should be smaller than 45°.

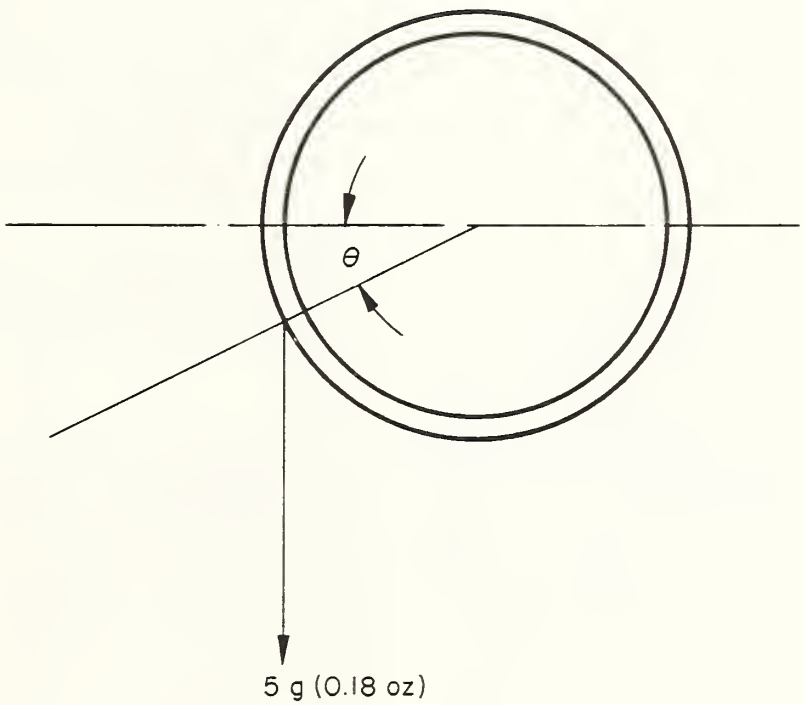


Fig. A1
Setup for Layer-to-Layer Adhesion Test

Appendix B

Measurement of Light Transmittance

B1. Introduction

This Appendix outlines the general principles of a test device and the test method to be employed when measuring the radiation (light) transmittance of magnetic tape, including leader tape.

For the purpose of this document, light transmittance is defined by convention as the relationship between the reading obtained from the test device with the tape sample inserted and the reading obtained when no sample is present. The transmittance value is expressed as the percentage ratio of the two readings.

The essential elements of the test device are as follows:

(1) The radiation (light) source
(2) The optical path
(3) The measuring mask
(4) The photocell
(5) The measuring equipment

B2. Description of the Test Device

B2.1 Radiation (Light) Source. A tungsten lamp is used as the radiation (light) source and should be operated in an underrun state. The color temperature should be 2000 K ± 200 K, and a resulting illumination at the surface of the tape sample of about 5000 lux is recommended.

B2.2 Optical Path. The radiation should be perpendicular to the tape sample and be of substantially uniform intensity. Typically the tape sample should be separated from the lamp by a distance of 150 mm (5.9 in).

An intermediate mask of the form shown in Fig. B1 is recommended in order to sensibly ensure that scattered radiation does not enter the mask area.

B2.3 Measuring Mask Geometry. The measuring mask should be constructed in one piece and in accordance with Fig. B2. A good matt black finish capable of absorbing infrared radiation is necessary.

Special care must be taken to ensure that the tape sample to be measured is maintained flat in contact with the inner face of the mask.

B2.4 Photocell. A flat silicon photocell should be used. Its dimensions must be such that the active area of the photocell exceeds the diameter of the mask orifice. It should be mounted parallel and in proximity to the outer face of the mask.

B2.5 Measuring Equipment. The measuring equipment should be connected directly across the photocell to measure the output current. In order to be able to set the measuring equipment to full-scale deflection (100%) a shunt potentiometer in the circuit must be provided or a fine adjustment of the lamp power supply voltage is required.

The load impedance across the photocell should be as low as possible and must not exceed 500 Ω. The instrument should have a nominal accuracy of ± 0.1%.

B.3 Test Procedure. For the purpose of the test a sample strip of tape not shorter than 250 mm (9.84 in) is used. The procedure is as follows:

(1) The measuring equipment is set to full-scale reading, representing 100%.

(2) The sample strip is inserted, and 45 observations on different points along the sample are recorded.

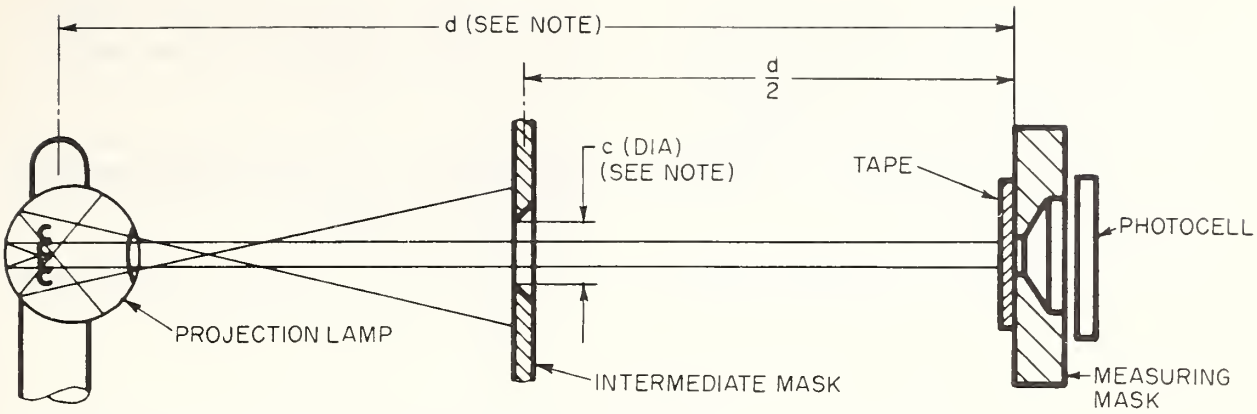
(3) The sample strip is then withdrawn, and full-scale deflection (100%) is rechecked. If the reading lies outside the range of 99% to 101% the equipment is reset to 100% and a new set of 45 observations is recorded.

B.4 Guidance on Construction

B4.1 Experience has shown that a projector lamp is most suited as the radiation source. When selecting a lamp, care must be taken to avoid a lamp with optical inhomogeneities in the glass envelope. Also, if mirrors or lenses are used in the optical path, they must be placed such that no filament image occurs in the proximity of the mask and photocell area. It is necessary to operate the lamp from a stabilized, regulated power supply.

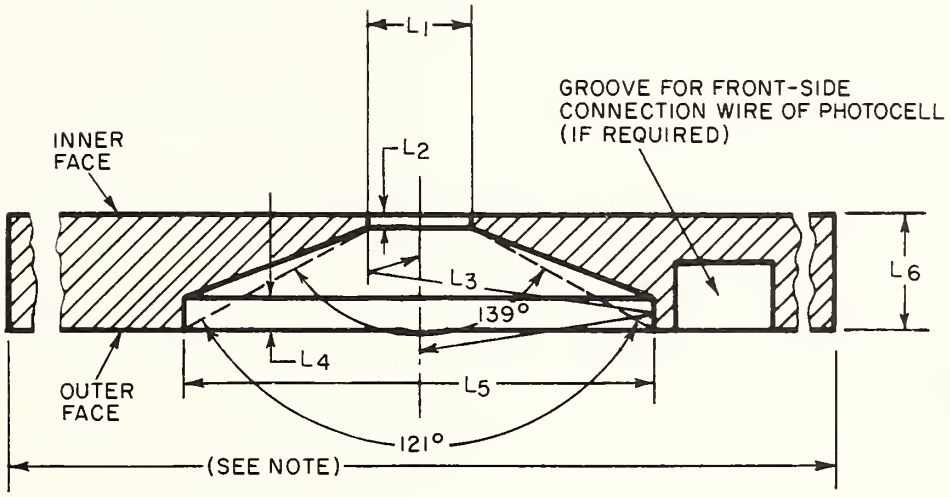
B4.2. Special attention must be paid to all surfaces parallel to the optical path and in proximity to the mask and photocell to avoid reflection of light. Similarly, the method of inserting the tape must ensure that no ambient light leaks through any slot arrangement.

B4.3 The accuracy of the measurement is dependent not only on attaining the dimensional tolerance shown in Fig. B2, but also on the subsequent coating of the



NOTE: d = approximately 150 mm (5.9 in); c = approximately 12 mm (0.5 in).

Fig. B1
Diagram of Device for Measurement of Light Transmittance



NOTE: Dimension determined by user.

Dimension	Inches			Millimeters		
	Min	Nom	Max	Min	Nom	Max
L_1	0.0709	–	0.0748	1.8	–	1.9
L_2	0.0060	–	0.0098	0.15	–	0.25
L_3	–	0.0039	–	–	0.1	–
L_4	0.0197	–	0.0236	0.5	–	0.6
L_5	0.3150	–	0.3189	8.0	–	8.1
L_6	0.0748	–	0.0795	1.90	–	2.02

Fig. B2
Measuring Mask

surface with a high-quality optical matt black paint. The mask should be checked after coating to ensure that the small hole remains in tolerance. The method of holding the sample must be such that the tape is maintained flat in contact with the face of the mask. However, it must allow the sample to be moved without physical damage or distortion.

B4.4 The photocell must be mounted with care, taking special precaution that the photocell leads do not interfere with the mounting arrangement. It is advisable for the face of the photocell to press slightly on the outer face of the mask.

B4.5 An effective means for providing periodical calibration should be incorporated by inserting an opaque object for 0% light transmittance and a filter glass for 75% light transmittance.

B4.6 The test device should be cleaned periodically.

American National Standards on Computers and Information Processing

X3.1-1976 Synchronous Signaling Rates for Data Transmission

X3.2-1970 (R1976) Print Specifications for Magnetic Ink Character Recognition

X3.3-1970 (R1976) Bank Check Specifications for Magnetic Ink Character Recognition

X3.4-1977 Code for Information Interchange

X3.5-1970 Flowchart Symbols and Their Usage in Information Processing

X3.6-1965 (R1973) Perforated Tape Code for Information Interchange

X3.9-1966 FORTRAN

X3.10-1966 Basic FORTRAN

X3.11-1969 Specification for General Purpose Paper Cards for Information Processing

X3.12-1970 Vocabulary for Information Processing

X3.14-1973 Recorded Magnetic Tape for Information Interchange (200 CPI, NRZI)

X3.15-1976 Bit Sequencing of the American National Standard Code for Information Interchange in Serial-by-Bit Data Transmission

X3.16-1976 Character Structure and Character Parity Sense for Serial-by-Bit Data Communication in the American National Standard Code for Information Interchange

X3.17-1977 Character Set and Print Quality for Optical Character Recognition (OCR-A)

X3.18-1974 One-Inch Perforated Paper Tape for Information Interchange

X3.19-1974 Eleven-Sixteenths-Inch Perforated Paper Tape for Information Interchange

X3.20-1967 (R1974) Take-Up Reels for One-Inch Perforated Tape for Information Interchange

X3.21-1967 Rectangular Holes in Twelve-Row Punched Cards

X3.22-1973 Recorded Magnetic Tape for Information Interchange (800 CPI, NRZI)

X3.23-1974 Programming Language COBOL

X3.24-1968 Signal Quality at Interface between Data Processing Terminal Equipment and Synchronous Data Communication Equipment for Serial Data Transmission

X3.25-1976 Character Structure and Character Parity Sense for Parallel-by-Bit Communication in the American National Standard Code for Information Interchange

X3.26-1970 Hollerith Punched Card Code

X3.27-1977 Magnetic Tape Labels and File Structure for Information Interchange

X3.28-1976 Procedures for the Use of the Communication Control Characters of American National Standard Code for Information Interchange in Specified Data Communication Links

X3.29-1971 Specifications for Properties of Unpunched Oiled Paper Perforator Tape

X3.30-1971 Representation for Calendar Date and Ordinal Date for Information Interchange

X3.31-1973 Structure for the Identification of the Counties of the United States for Information Interchange

X3.32-1973 Graphic Representation of the Control Characters of American National Standard Code for Information Interchange

X3.34-1972 Interchange Rolls of Perforated Tape for Information Interchange

X3.36-1975 Synchronous High-Speed Data Signaling Rates between Data Terminal Equipment and Data Communication Equipment

X3.37-1977 Programming Language APT

X3.38-1972 Identification of States of the United States (Including the District of Columbia) for Information Interchange

X3.39-1973 Recorded Magnetic Tape for Information Interchange (1600 CPI, PE)

X3.40-1976 Unrecorded Magnetic Tape for Information Interchange (9-Track 200 and 800 CPI, NRZI, and 1600 CPI, PE)

X3.41-1974 Code Extension Techniques for Use with the 7-Bit Coded Character Set of American National Standard Code for Information Interchange

X3.42-1975 Representation of Numeric Values in Character Strings for Information Interchange

X3.43-1977 Representations of Local Time of the Day for Information Interchange

X3.44-1974 Determination of the Performance of Data Communication Systems

X3.45-1974 Character Set for Handprinting

X3.46-1974 Unrecorded Magnetic Six-Disk Pack (General, Physical, and Magnetic Characteristics)

X3.48-1977 Magnetic Tape Cassettes for Information Interchange (3.810-mm [0.150-in] Tape at 32 bpmm [800 bpi], PE)

X3.49-1975 Character Set for Optical Character Recognition (OCR-B)

X3.50-1976 Representations for U.S. Customary, SI, and Other Units to Be Used in Systems with Limited Character Sets

X3.51-1975 Representations of Universal Time, Local Time Differentials, and United States Time Zone References for Information Interchange

X3.52-1976 Unrecorded Single-Disk Cartridge (Front Loading, 2200 BPI), General, Physical, and Magnetic Requirements

X3.53-1976 Programming Language PL/I

X3.54-1976 Recorded Magnetic Tape for Information Interchange (6250 CPI, Group Coded Recording)

X3.55-1977 Unrecorded Magnetic Tape Cartridge for Information Interchange, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded

X3.56-1977 Recorded Magnetic Tape Cartridge for Information Interchange 4 Track, 0.250 Inch (6.30 mm), 1600 bpi (63 bpmm), Phase Encoded

X3.57-1977 Structure for Formatting Message Headings for Information Interchange Using the American National Standard Code for Information Interchange for Data Communication System Control

X3.58-1977 Unrecorded Eleven-Disk Pack General, Physical, and Magnetic Requirements

For a free and complete list of all American National Standards, write:

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